COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY
U.S. House of Representatives
Hearing Charter

Science and Energy Research Infrastructure Needs of the U.S. Department of Energy
Wednesday, April 27, 2022
11:00AM ET

PURPOSE

The purpose of this hearing is to examine the goals and impacts of the U.S. Department of Energy's (DOE) Fiscal Year (FY) 2023 budget request, with a primary focus on budget planning and management of construction of the DOE Office of Science's (SC) user facilities, experiments, and upgrades. There will be additional questioning about the research, development, demonstration, and commercialization programs and activities carried out by DOE.

WITNESS

- **Dr. Geraldine Richmond**, Under Secretary for Science and Innovation, U.S. Department of Energy

BACKGROUND

The Department of Energy's Office of Science is the lead federal agency supporting scientific research for energy applications and the nation's largest supporter of research in the physical sciences, supporting nearly 29,000 investigators at over 300 institutions and the DOE laboratories.[1] SC's portfolio has two principal thrusts: direct support of scientific research and support of the development, construction, and operation of large-scale experiments and unique, open-access scientific user facilities. These missions are primarily pursued by six research program offices: Advanced Scientific Computing Research (ASCR), Basic Energy Sciences (BES), Biological and Environmental Research (BER), Fusion Energy Sciences (FES), High Energy Physics (HEP), and Nuclear Physics (NP). It also supports focused research and development activities in isotope production and accelerator technology, as well as education initiatives through its Workforce Development for Teachers and Scientists program and general infrastructure projects for research facilities through its Science Laboratories Infrastructure (SLI) program.

In carrying out these activities, SC stewards 10 of the 17 DOE laboratories. The laboratories execute long-term government missions and develop unique, often multidisciplinary, scientific instruments and resources beyond the scope of academic and industrial institutions. Key among the assets provided by the National Laboratory complex are user facilities, which are used by nearly 34,000 researchers per year from universities, national laboratories, industry, and

[1] Department of Energy FY 2023 Congressional Budget Request Budget-in-Brief. https://www.energy.gov/sites/default/files/2022-04/doe-fy2023-budget-in-brief-v6.pdf

international partners.[2] These facilities enable access to advanced scientific tools including particle accelerators, colliders, high-performance computing systems, light sources and neutron sources, nanoscale science instruments, and platforms for observing and analyzing the environment and atmosphere.

SC also supports the development, construction, and operation of large-scale scientific experiments. These projects underpin advances in transformative technologies that range from next generation batteries to fusion energy systems. They also enable research that helps revolutionize our understanding of the fundamental nature of matter, including enigmatic subatomic and elementary particles. Given their scale and complexity, the success of these experiments also relies on robust collaboration and contributions from foreign partners, allowing SC and its National Laboratories access to a vast international talent pool while solidifying U.S. global leadership in science and technology.

DOE OFFICE OF SCIENCE BUDGET

Overview of Persistent Budgetary Challenges

To support both its research and construction portfolios, SC must have a budget and outyear spending strategy that adequately meets the demands inherent to these activities. Large-scale construction projects are especially sensitive to fluctuations in the annual budget and appropriations process because experiments and user facilities often take many years to progress from conception through construction and ultimately operation. This requires consistent support for "standing armies" of scientists, engineers, contractors, skilled tradespeople, and others all collectively working to achieve specific project milestones in a timely manner. A contingency fund is also necessary for addressing the unforeseen challenges that often accompany major construction projects. Inadequate funding can result in delays that put projects behind schedule and ultimately increase their total price tag. Such funding levels and resultant delays have been interpreted by project contractors and collaborators as a decrease in the Department's commitment to these projects. This is significantly problematic for maintaining longstanding research collaborations with the international scientific community, as many of these projects rely on international participation to develop the requisite technology, maximize scientific output, and reduce the cost burden on any single partner.

Budget requests that propose cuts, stagnation, or slow growth to the SC topline cause downward pressure on the funding profiles for large-scale construction projects. When this occurs, one option is to shift dollars away from research programs to better address the needs on the construction side of the ledger. This approach would result in adverse long-term effects. SC's research funding supports thousands of researchers in the National Laboratories, universities, and the private sector, and plays a fundamental role in both driving advances in myriad scientific fields and contributing to the workforce pipeline that enables DOE to meet its mission needs. These research programs are also essential to enabling progress in areas of national strategic importance such as quantum information science, artificial intelligence, and microelectronics.

[2] Ibid.

FY 2023 Budget Request

President Biden released his FY 2023 budget request on March 28, 2022. While the Administration's request would see DOE's topline discretionary funding increase by 7.4 percent to a total of $48.2 billion over the FY 2022 enacted level of $44.9 billion, growth for SC would be comparatively slow at 4.3 percent for a total of $7.8 billion. This also represents a decline in percentage terms from the Administration's FY 2022 request, which proposed a 5.9 percent increase for SC—which was also disproportionately low at the time. The disparity in FY 2023 is notable when compared to the requests for other DOE research programs such as those carried out by the Office of Energy Efficiency and Renewable Energy (EERE) and the Advanced Research Projects Agency-Energy (ARPA-E), which would grow by 44.9 percent and 55.6 percent, respectively. Outside of DOE, the FY 2023 request for SC also lags behind other science agencies such as the National Science Foundation, which would receive a 19 percent increase.

Under the Administration's FY 2023 budget request for SC, many current major construction projects would not be supported at levels that are needed, according to funding profile estimates determined by DOE and the Department's National Laboratories, to maintain their project schedules and minimize their total costs. The budget requests for SC over the previous several fiscal years have also had this deficiency. This issue is not limited to one program office, and would stymie efforts to control the cost and schedule of several projects across BES, FES, HEP, NP, and the Isotope R&D and Production (IP) program, including the Spallation Neutron Source-Second Target Station (SNS-STS), the National Synchrotron Light Source-II (NSLS-II) Beamline Buildout[3], the U.S. contribution to the ITER international fusion project, the Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment (LBNF/DUNE), the Electron-Ion Collider (EIC), and the Stable Isotope Production and Research Center (SIPRC). The request would also eliminate funding for three SLI projects at Ames National Laboratory, Oak Ridge National Laboratory, and Thomas Jefferson National Accelerator Facility, characterizing the decision as necessary to avoid an overcommitment of SC resources.

The years-long persistence of the budgetary challenges mentioned above has forced DOE to revise its own project funding estimates on an annual basis. As a consequence, information about project profiles provided to the Committee by the Department has been inconsistent, further amplifying concerns over total project cost increases and schedule slippage.

In addition, the Department has informed the Committee that several projects under construction are being significantly impacted by the effects of the COVID pandemic, including increased costs of materials and labor as well as schedule delays due to supply chain shortages. These issues have introduced large uncertainties regarding the adequacy of current project contingency funds, and may result in a substantial reduction in the capabilities of these facilities in order to maintain their previously approved total project cost levels. However, the impacts of the COVID pandemic on SC's research programs, construction projects, and facility operations are not addressed in the President's Budget Request.

[3] Formally named the NSLS-II Experimental Tools II (NEXT-II) Project, to be followed by a NEXT-III project.

Fusion Research

Also of note, on March 17th, 2022, the White House held a three-hour summit to announce a new fusion energy initiative and discuss the progress and potential benefits of improved support for fusion research and development.[4] Yet the FY 2023 request for SC's fusion program would amount to a 1.4 percent increase over the FY 2022 appropriated level. If enacted, this would effectively be a cut to the program under typical annual research cost inflation levels.

COMMITTEE ACTIVITIES

Legislation

The Committee has sought to empower SC to complete the projects in its construction portfolio on time and on budget. Both the *Department of Energy Science for the Future Act* (H.R. 3593) and the *America COMPETES Act of 2022* (H.R. 4521) authorize five-year funding profiles that would enable optimal operation start dates for each SC project without compromising scientific scope. These figures were also included in the Committee-passed portion of the *Build Back Better Act* (H.R. 5376). While this would necessitate a more aggressive ramp-up of funding early on, the figures included in these bills were informed by comprehensive discussions with DOE, the National Laboratories, and other stakeholders who are directly involved with these projects.

The below is an overview of several SC construction projects that highlight the discrepancy between the project budget profiles proposed by the Administration and the Committee. Note that the budgetary challenges highlighted in this charter are also not limited to these projects, but are exemplified across numerous smaller-scale construction projects, Major Items of Equipment, and SLI projects.

- **Spallation Neutron Source-Second Target Station (SNS-STS)**: Hosted at Oak Ridge National Laboratory and overseen by BES, the SNS-STS is designed to provide transformative new capabilities for discovery science, enabling breakthroughs in many areas of materials research and development, including polymers, quantum matter, biotechnologies, structural materials, and energy storage.[5] The project received Critical Decision 1 (CD-1), Approve Alternative Selection and Cost Range, on November 23, 2020, which established the approved Total Project Cost (TPC) range of $1,800,000,000 to $3,000,000,000 and CD-2, Approve Performance Baseline, is expected 2Q FY 2025.[6]

  FY 2023 America COMPETES Act: $127,000,000
  FY 2023 President's Budget Request: $37,000,000

[4] https://www.whitehouse.gov/ostp/events-webinars/past-events/
[5] https://neutrons.ornl.gov/sts/sts-instrument-systems#:~:text=The%20Second%20Target%20Station%20(STS,%2C%20quantum%20matter%2C%20biotechnologies%2C%20structural
[6] FY 2023 Basic Energy Sciences Budget Request, page 47: https://www.energy.gov/sites/default/files/2022-04/FY2023-PresidentsRequest-BES.pdf.

- **U.S. Contribution to ITER:** The U.S. is a partner nation in ITER, an international collaboration of scientists and engineers working to design, construct, and assemble a burning plasma experiment that can demonstrate the scientific and technological feasibility of fusion. The project, which is overseen by FES, is managed by Oak Ridge National Laboratory. Partner labs are Princeton Plasma Physics Laboratory and Savannah River National Laboratory.[7] An independent review of CD-2, Approve Performance Baseline, for the U.S. Contributions to ITER—First Plasma subproject was completed in November 2016 and then subsequently approved by the Project Management Executive on January 13, 2017, with a TPC of $2,500,000,000. The estimated TPC range is $4,700,000,000 to $6,500,000,000, which includes all U.S. in-kind hardware and financial construction contributions through the completion of ITER.[8]

  FY 2023 America COMPETES Act: $325,000,000
  FY 2023 President's Budget Request: $240,000,000

- **Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment (LBNF/DUNE):** DUNE is an international flagship experiment to unlock the mysteries of neutrinos, and will be installed in the LBNF, under construction in the U.S. DUNE will pursue three major science goals: find out whether neutrinos could be the reason the universe is made of matter; look for subatomic phenomena that could help realize Einstein's dream of the unification of forces; and watch for neutrinos emerging from an exploding star, perhaps witnessing the birth of a neutron star or a black hole.[9] The project is overseen by HEP and hosted at the Fermi National Accelerator Laboratory. The preliminary TPC range is $1,260,000,000 to $1,860,000,000, as approved on September 1, 2016. The project completed the reliability improvements needed to support excavation in early 2021 and the excavation work began in April 2021. Updated planning and analysis led to an increased scope and TPC for LBNF/DUNE of $3,000,000,000, which is being evaluated prior to establishing the project baseline.[10]

  FY 2023 America COMPETES Act: $325,000,000
  FY 2023 President's Budget Request: $176,000,000

- **Electron-Ion Collider (EIC):** Overseen by NP and housed at Brookhaven National Laboratory, and developed in partnership with the Thomas Jefferson National Accelerator Facility, the EIC will be a particle accelerator that collides electrons with protons and nuclei to produce snapshots of those particles' internal structure. The electron beam will reveal the arrangement of the quarks and gluons that make up the protons and neutrons of nuclei, enabling greater understanding of the "strong nuclear force" and the role of gluons in matter.[11] CD-0, Approve Mission Need, was received on

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[7] https://www.usiter.org/project/project-history
[8] FY 2023 Fusion Energy Sciences Budget Request, page 33: https://www.energy.gov/sites/default/files/2022-04/FY2023-PresidentsRequest-FES.pdf.
[9] https://lbnf-dune.fnal.gov/
[10] FY 2023 High Energy Physics Budget Request, pages 35-36: https://www.energy.gov/sites/default/files/2022-04/FY2023-PresidentsRequest-HEP.pdf.
[11] https://www.bnl.gov/eic/

December 19, 2019, followed by CD-1, Approve Alternative Selection and Cost Range on June 29, 2021. The estimated TPC range for the EIC project is $1,700,000,000 to $2,800,000,000.[12]

FY 2023 America COMPETES Act: $155,000,000
FY 2023 President's Budget Request: $20,000,000

The Committee has also been closely tracking the progress of several projects that are at earlier stages of maturity. An overview of two projects supported through BES and IP is included below to highlight the potential for additional significant impacts if these funding disparities continue. The Administration's FY 2022 and FY 2023 budget requests have proposed funding levels that do not match the ideal funding profiles[13] provided to the Committee by DOE or the relevant National Laboratories.

- **NSLS-II Experimental Tools II and III (NEXT-II and NEXT-III):** Collectively referred to in this Charter as the NSLS-II Beamline Buildout, NEXT-II and NEXT-III will add new beamlines to the NSLS-II Facility at Brookhaven National Laboratory as part of a phased buildout to provide advances in scientific capabilities for the soft x-ray user community. NEXT-II will add three beamlines, while NEXT-III may add as many as 19 depending on the outcome of the project planning process, per information provided to the Committee by relevant stakeholders. NEXT-II received CD-2, Approve Performance Baseline, and CD-3, Approve Start of Construction, on October 13, 2021. The approved TPC is $94,500,000.[14] While the budget request for NEXT-II matches the ideal funding level for FY 2023 provided to the Committee by DOE, this figure assumed a more robust funding level in FY 2022 than what was actually requested or appropriated. The previous year's shortfall has led to a delay in the completion of the project by 18 months and an additional $5,000,000 to the TPC. NEXT-III is at an earlier stage of development and does not yet have a comprehensive funding profile. NEXT-II and NEXT-III are overseen by BES.

  FY 2022 President's Budget Request and Appropriations: $15,000,000
  FY 2022 Ideal Funding Profile: $41,000,000

- **Stable Isotope Production and Research Center (SIPRC):** Housed at Oak Ridge National Laboratory and overseen by IP, the SIPRC is intended to expand gas centrifuge production capability and significantly increase electromagnetic isotope separation production capability to meet the Nation's growing demand for stable isotopes and

[12] FY 2023 Nuclear Physics Budget Request, page 39: https://www.energy.gov/sites/default/files/2022-04/FY2023-PresidentsRequest-NP.pdf.
[13] For the purposes of this charter, project funding profile estimates provided to the Committee by DOE or the relevant National Laboratories that maintain project schedules while minimizing total project costs will be referred to as "ideal funding profiles."
[14] FY 2023 Basic Energy Sciences Budget Request, page 56: https://www.energy.gov/sites/default/files/2022-04/FY2023-PresidentsRequest-BES.pdf

mitigate dependence on foreign countries for stable isotope supply.[15] Isotopes are high-priority commodities that are essential to a broad range of applications including medical diagnoses and treatment, discovery science, advanced manufacturing, and emerging technologies such as quantum information science. CD-1, Approve Alternative Selection and Cost Range, and Subproject-1 CD-3A, Approve Long Lead Procurement, was received on November 4, 2021. The current TPC point estimate is $250,000,000 with an updated preliminary TPC range of $187,000,000 to $338,000,000.[16]

FY 2023 President's Budget Request: $12,000,000
FY 2023 Ideal Funding Profile: $74,400,000

Oversight Activities

During the 117th Congress, the Committee has held several hearings examining various SC programs and initiatives. This includes a May 4, 2021 hearing on climate and energy science activities in BER and BES;[17] a May 19, 2021 hearing on SC's scientific computing capabilities, which are led by ASCR;[18] and a November 17, 2021 hearing focused on fusion energy.[19] Other Committee hearings highlighting SC include testimony given by Secretary of Energy Jennifer Granholm on May 27, 2021;[20] a December 2, 2021 hearing on federal investment in microelectronics research and development;[21] and a hearing focused on bioenergy research and development on March 16, 2022.[22] In these hearings, Committee Members, including Chairwoman Johnson, have repeatedly engaged with DOE officials on the need for robust support for SC, including in response to the FY 2022 budget request. Separate from these hearings, Committee staff have been consistently engaging with officials from SC and DOE leadership, as well as the White House through the Office of Management and Budget and the Office of Science and Technology Policy, to convey the Committee's interest in seeing the Administration provide a budget request that adequately meets SC's research and construction needs.

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[15] An element's isotope is determined by the number of neutrons contained in the nucleus of its atoms. For example, the element carbon occurs naturally as three isotopes: carbon-12, which contains six neutrons; carbon -13, which contains seven neutrons; and carbon-14, which contains eight neutrons. More at https://www.energy.gov/science/doe-explainsisotopes.

[16] FY 2023 Isotope R&D Production Budget Request, page 5: https://www.energy.gov/sites/default/files/2022-04/FY2023-PresidentsRequest-IRP.pdf

[17] https://science.house.gov/hearings/climate-and-energy-science-research-at-the-department-of-energy

[18] https://science.house.gov/hearings/accelerating-discovery-the-future-of-scientific-computing-at-the-department-of-energy

[19] https://science.house.gov/hearings/fostering-a-new-era-of-fusion-energy-research-and-technology-development

[20] https://science.house.gov/hearings/overview-of-the-science-and-energy-research-enterprise-of-the-us-department-of-energy

[21] https://science.house.gov/hearings/ensuring-american-leadership-in-microelectronics

[22] https://science.house.gov/hearings/bioenergy-research-and-development-for-the-fuels-and-chemicals-of-tomorrow

OTHER ITEMS IN THE REQUEST

The discretionary request provides $16 billion overall for DOE science and energy research, development, demonstration, and commercial application activities in FY 2023, which would represent a 16.7 percent increase over the total appropriated level for these activities in FY 2022. As shown above, there is wide variation in how this proposed increase is distributed among DOE's programs. In addition to the relatively minor gain proposed for SC, annual funding for the Office of Nuclear Energy would grow by 1.2 percent. On the other hand, as noted above, EERE R&D and ARPA-E would receive increases of 44.9 percent and 55.6 percent, respectively. More toward the middle of the spectrum are the Office of Fossil Energy and Carbon Management, the Office of Electricity, and the Office of Cybersecurity, Energy Security, and Emergency Response, which would grow by 8.2 percent, 7.2 percent, and 8.7 percent, respectively. It is important to note that the enacted Infrastructure Investment and Jobs Act (IIJA) included billions of dollars in direct funding for demonstration projects in several of these advanced technology areas, which may have informed many of these proposed allocations. However, no funds in the IIJA were allocated for programs, projects, or facilities stewarded by SC or ARPA-E.